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ATTRACTIVE PRICES AND EURO-ROUNDING EFFECTS ON INFLATION

Luc Aucremanne[(*)]
David Cornille[(**)]

The views expressed in this paper are those of the authors and do not necessarily reflect the views of the National Bank of Belgium.

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(*) NBB, Research Department (e-mail: luc.aucremanne@nbb.be).
(**) NBB, Research Department (e-mail: david.cornille@nbb.be).

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Abstract

Approximately 70% of Belgian consumer prices are to be considered as attractive prices, namely psychological prices, fractional prices - i. e. prices which are convenient to pay - and round prices. Conversion of these prices into euro generally leads to prices which are no longer attractive and it is very likely that retailers will round their prices to attractive euro prices. The public fears that rounding will be upward rather than symmetric. This paper simulates in the first instance a worst-case scenario, whereby all attractive BEF prices are systematically rounded up to the nearest attractive euro price. The effect on the consumer price index ranges from 0.54 to 0.72%. Such a scenario is however very unlikely, as factors such as competition on product markets, the currently prevailing demand conditions, the commitments made by organisations representing the enterprise sector and the vigilant attitude of consumers restrain the possibility of rounding up. In order to obtain a more realistic picture, the paper investigates in a second step whether rounding-up effects were found after the major change in VAT rates in April 1992. These effects seem marginal, although it should be acknowledged that it was difficult to isolate rounding effects from regular price changes. Any ex post assessment of the euro changeover will face a similar identification problem.

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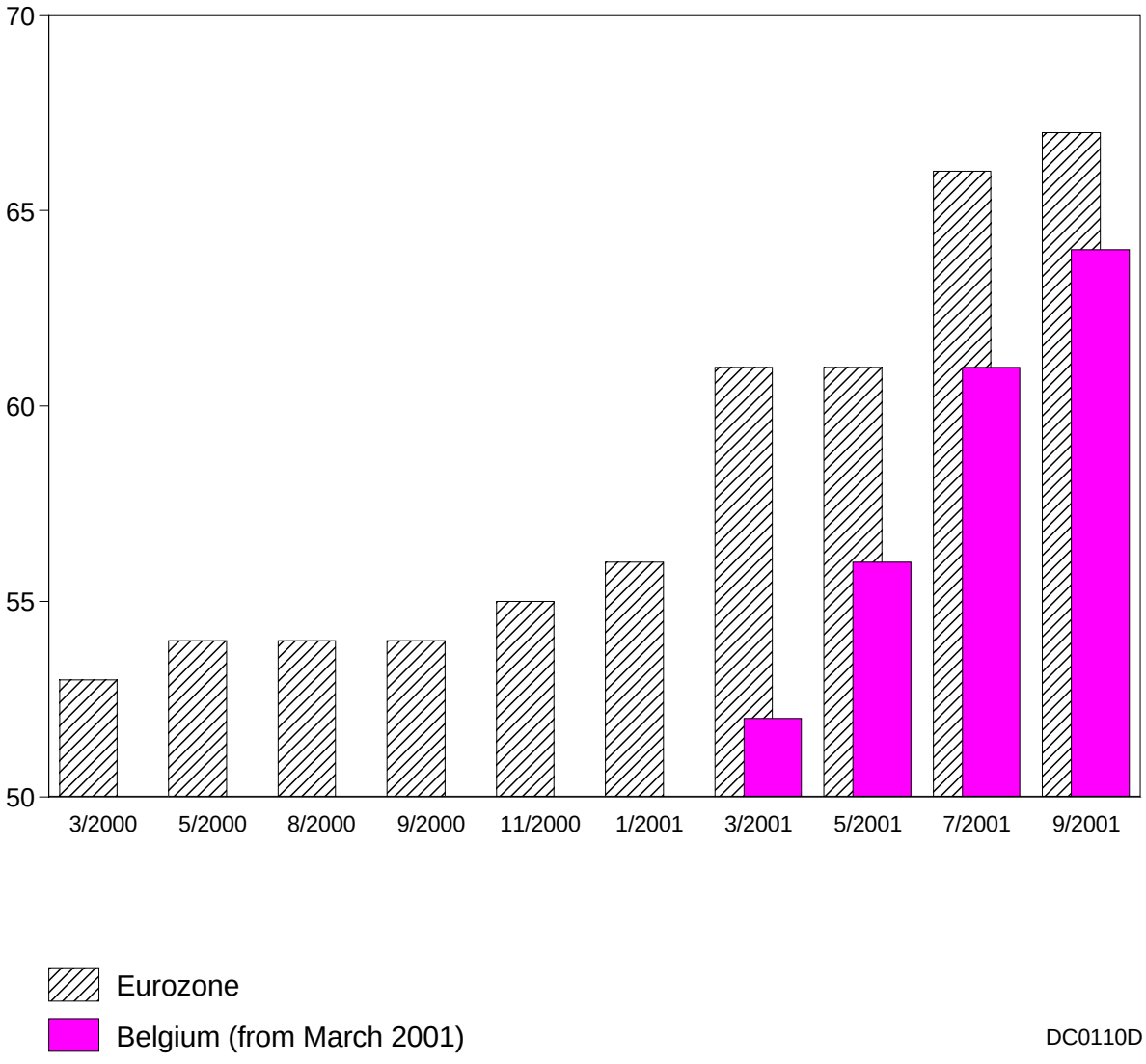
1. INTRODUCTION

The *Flash Eurobarometer,* published on a regular basis by the European Commission, is revealing growing concern among consumers about possible abuses and cheating on prices during the changeover to the euro (Figure 1). This is the case in the euro area as a whole as well as in Belgium, even though Belgian consumers seem somewhat more confident. Those fears confirm the attachment of consumers to price stability. This paper tries to provide a partial answer to the question whether these fears are justified.

Figure 1 - Fears of abuses and cheating on prices

(Strongly disagree = 0 <=> 100 = Strongly agree)



Source: Flash Eurobarometer.

Three different channels through which the euro changeover could affect prices can be identified. The first channel is the passing-on of costs and benefits linked to the introduction of the euro. According to the Bank's euro survey[1], the major part of the costs is attributable to the adjustment of the IT infrastructure, staff training and internal communication. Retailing differs from the other branches in the larger proportion of costs incurred in modifying payment points, additional cash-handling, special security measures and dual pricing. In the short term this could lead to price increases, when firms try to pass on these costs to consumers in an attempt to stabilise their profit margins. However, as these costs represent only 0.29% of the turnover they seem rather limited. Moreover their temporary nature, as well as the fact that about half of these costs would already have been borne before 2001, should be emphasised. On the basis of these findings it does not seem very likely that this channel will give rise to significant price increases. In the longer term (transitory) costs should be more than compensated for by (permanent) benefits, which should eventually result in a permanent decrease of the price level. The most frequently mentioned areas where the introduction of the euro leads to benefits are price transparency, the reduction of transaction costs and exchange rate risks. Particularly the higher degree of competition in the euro area resulting from the enhanced price transparency after the euro changeover should have a downward effect on prices.

The second channel is the clustering of price changes not related to the introduction of the euro. As price changes entail considerable fixed costs (often referred to as menu costs), the changeover to the euro constitutes a natural adjustment point for price changes usually spread over a longer period of time. This effect is temporary by nature, and is neutral in the medium term. It is however clear that this phenomenon complicates the identification of changeover effects on prices.

A third channel, which is often mentioned in the press, is the rounding of euro prices to obtain *attractive* prices. Converted to euro, attractive prices expressed in national currency may not look attractive any more, which could give rise to the temptation to round prices up to the nearest attractive price in euro. In this paper we focus on this third channel in greater detail, without exploring the theoretical factors that could justify this rounding up. As it is difficult to assess how prices will actually be rounded, this paper considers the worst-case scenario whereby it is assumed that all attractive BEF prices, after conversion into euro, are systematically rounded up to the nearest attractive euro

[1] Survey conducted in August 2001, National Bank of Belgium (2001).

price. This approach is to a large extent inspired by a similar study done at the Nederlandsche Bank (see Folkertsma (2001)). In a second step, the likelihood of this maximum effect is evaluated, on the basis of the analysis of the 1992 VAT rate change. Comparing the price actually observed after a VAT change with the theoretical price calculated as if the VAT rate changes were strictly applied can indeed yield some information on how attractive and ordinary prices have been rounded.

The remainder of the paper is structured as follows. Section 2 presents the worst-case-scenario simulations. Section 3 examines the effects of rounding for the 1992 VAT rate change. Finally, Section 4 presents some conclusions.

2. A WORST-CASE SCENARIO

In this section, we start by showing that attractive pricing is a widespread practice for Belgian consumer prices, as is the case in many other countries. After conversion into euro, many prices will no longer look attractive, and it is impossible to guess what will happen to those prices. Either they remain unattractive or they are rounded to an attractive euro price. This rounding may be systematically upwards or systematically downwards, or both types of rounding may occur simultaneously, so that the conversion will be globally neutral. In order to assess the maximal inflationary risk, this section explores the worst-case scenario of systematically rounding BEF prices up to the nearest attractive price in euro.

2.1. Data source and description

This study makes extensive use of the individual price database used by the Ministry of Economic Affairs (MEA) to compute the National Index of Consumer Prices (NICP)[2]. The simulations and the analysis which follow are based on the December 2000 subsample, containing 106,159 prices for 394 different products. Prices are recorded at more than 10,000 selling points spread over 65 different areas. The database used covers 68.1% of the NICP (see Table 1). The remaining items (31.9% of the NICP) not included in the database correspond to products that the CPI compilers follow centrally, such as electricity, gas, telecommunications, newspapers, insurance services, ...

In December 2000 there were 3,808 different prices in the database. As can be seen from the first level of Figure 2, the frequency distribution of these prices is far from uniform, and small prices have a higher frequency. The second level of Figure 2 shows the cumulative frequency for the entire sample. 25% of the prices are lower than 49 BEF, 50% lower than 149 BEF and 75% lower than 569 BEF. The maximum price in the database is 413,000 BEF.

Attractive prices or, in other words, prices often chosen for their believed attractiveness are responsible for a large proportion of the irregularity of the frequency distribution of distinct prices. This can be illustrated, as is done in Figure 3, by plotting the frequency of the last two digits of prices. Prices ending with 0, 5 or 9 do clearly have a

[2] The Ministry of Economic Affairs, where the CPI is computed, removed from the database any information that would enable the producer or the selling point to be identified.

higher frequency than other prices. Prices ending with 98 also have a higher frequency. This remains true for prices higher than 1,000 BEF (lower level of Figure 3), even though the picture changes considerably. In the latter figure, no more than six attractive last two digits (99, 95, 00, 90, 50 and 98) dominate the sample.

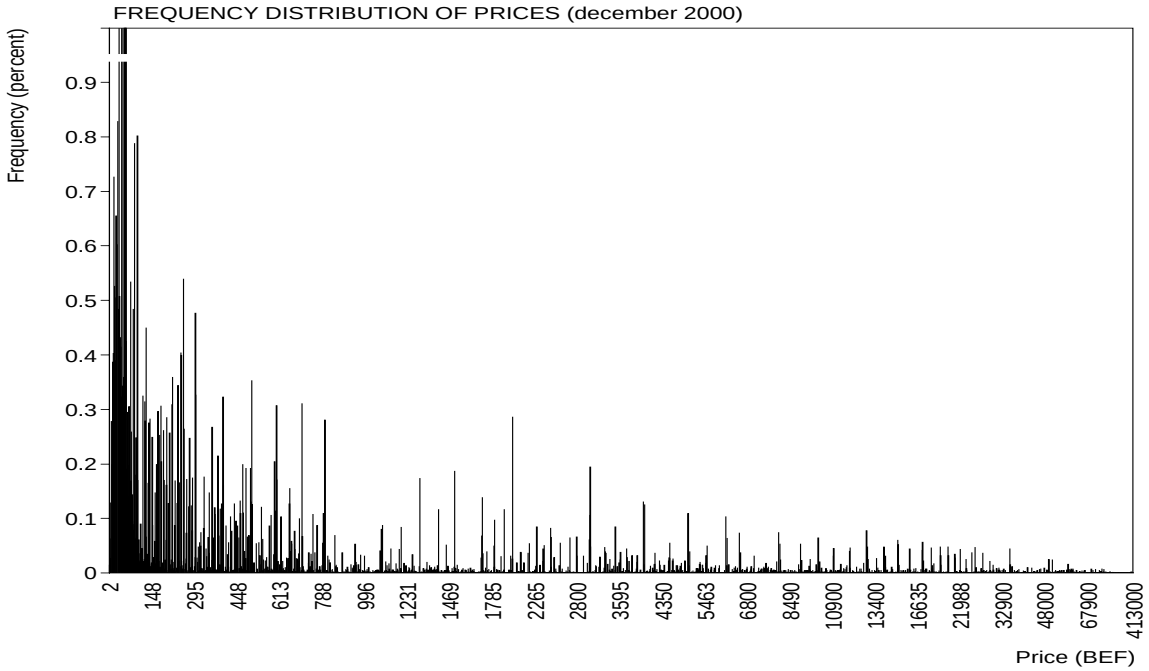
Table 1 - Coverage of the database (December 2000)

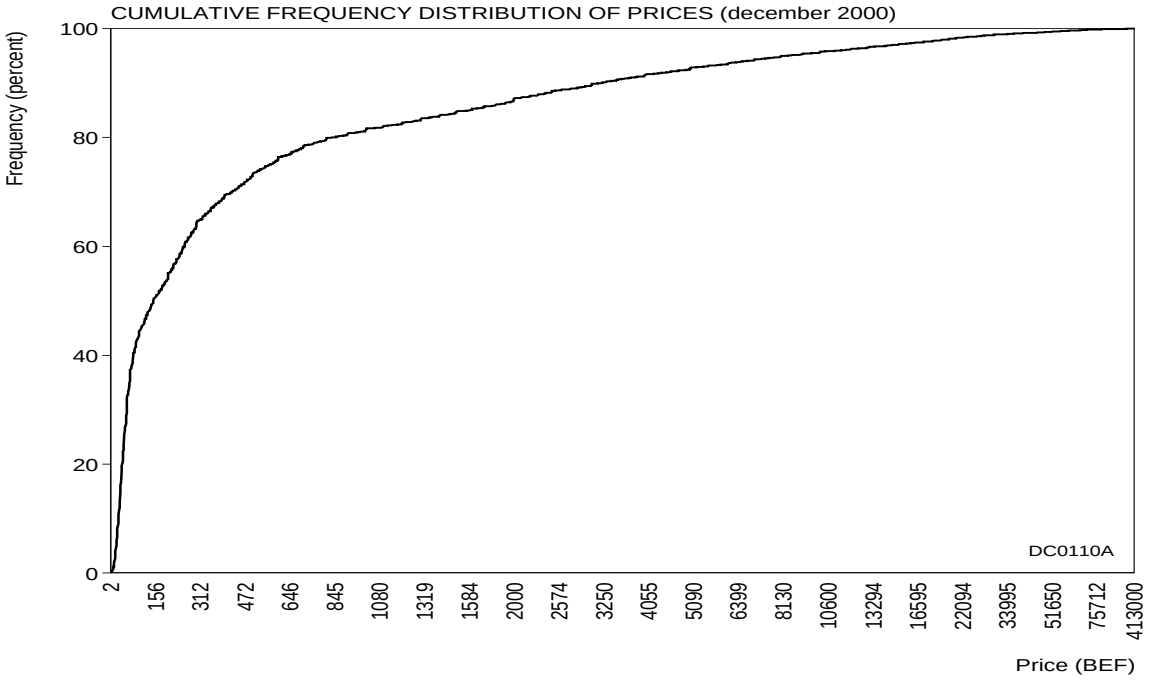
Coicop code (a)	Description	NICP weighting *(per mille)*	Number of observations	Coverage of the database	
				by category *(per cent)*	total *(per mille)*
01	Food and non-alcoholic beverages	214	60,980	99.8	213.9
02	Tobacco	13	1,089	100.0	13.2
03	Clothing and footwear	82	10,912	100.0	82.0
04	Housing, water, gas, electricity	147	2,058	28.1	41.2
05	Furnishing & maint. of housing.	86	11,669	100.0	86.1
06	Health care expenses	40	431	21.5	8.5
07	Transport	138	2,755	47.2	65.2
08	Communications	22	86	2.8	0.6
09	Leisure and culture	117	7,757	54.5	64.0
10	Education	4	-	-	-
11	Hotels, cafés and restaurants	66	3,035	96.3	63.8
12	Miscellaneous goods and services	70	5,387	60.6	42.5
00	**Total**	**1,000**	**106,159**	**68.1**	**680.8**

(a) Classification of individual consumption by purpose.

To simulate the rounding effects on inflation, one has to identify: (i) which attractive BEF prices are likely to be rounded; (ii) the level of the corresponding attractive euro price to which these prices will be rounded. This is done in subsections 2.2 and 2.3 of this part of the paper respectively. Subsection 2.4 presents the simulation results.

Figure 2 - Description of the database





2.2. Definition of attractive prices in BEF

Following Folkertsma (2001), we consider separately three categories of attractive prices defined in the marketing literature: psychological prices, fractional prices and round prices.

Psychological prices are prices ending with 9, as in 1,999 BEF. This type of price is frequently used because the last significant digit tends to be ignored by consumers within their scale of value for prices. Consumers are believed to make no distinction between 390 and 399 BEF, whereas they distinguish 399 from 400 BEF.

Fractional prices are amounts that are convenient to pay, such as 150 BEF. They require few coins and/or notes and only one coin or none in change. These prices are often used in bars and cafes or in public transport, for instance.

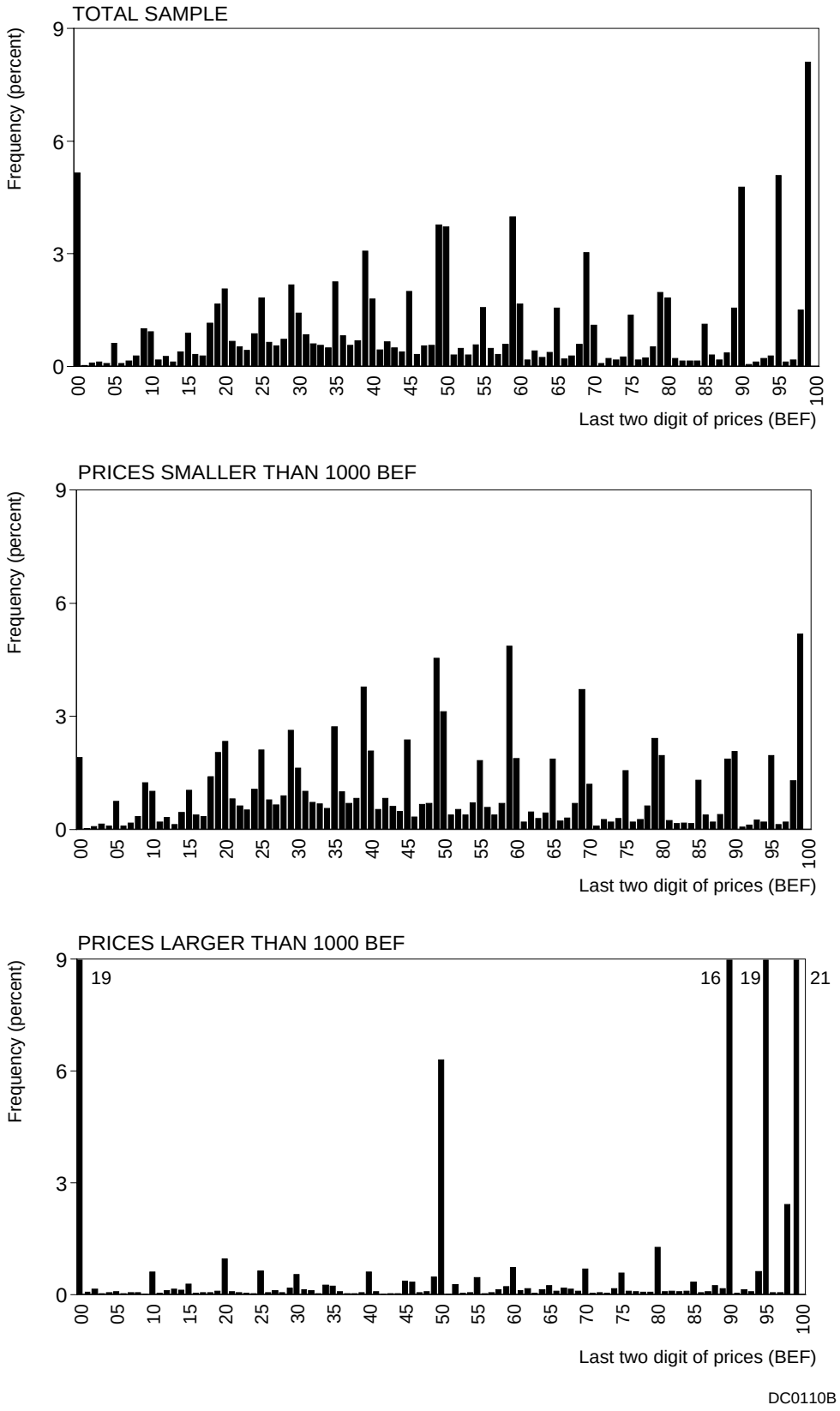
Round prices are prices generally used for larger amounts. It is not always easy to distinguish between round and fractional prices. Moreover the concept of "round price" may differ depending on the currency of denomination. For instance, in the Netherlands round prices are "prices without decimals" (almost 24% of all prices)[3], whereas in Belgium round prices would rather be multiples of 100 such as 400 or 1200 BEF. They represent 5% of all prices, and 19% of the prices higher than 1,000 BEF, as can be seen from the lower level of Figure 3.

However, the literature provides very little information on how to define precisely whether a price currently used is ordinary, psychological, fractional or round. Not all observed prices ending with 9 are necessarily psychological and, for instance, 969 BEF may be a psychological price although it has not been observed in the database.

Use has to be made, therefore, of an empirical definition of attractive prices, which ultimately has to be based on the frequency with which a particular price is observed in order to determine whether the price in question is observed more frequently to a significant extent. Such an empirical definition must however take account of the following two characteristics of the frequency distribution of observed prices (see Figure 2):

[3] See Folkertsma (2001).

Figure 3 - Frequency distribution of the last two digits of prices (from 00 to 99)



Note: decimal prices are not taken into account (they represent 2,8% of observed prices).

- small prices are more frequently observed than larger prices and hence the cut-off frequency for higher prices must be lower;

- the higher the price the greater the distance between two subsequent prices. There are indeed more distinct prices observed between 0 and 100 than between 500 and 600 BEF.

The so-called "rolling 75% percentile" procedure presented in Folkertsma (2001) takes these characteristics of the data into account and has been adopted here as well.

This procedure selects the first 100 distinct consecutive prices and tests the significance of the 50th distinct price. The selected prices are arranged in order of frequency and the 75% percentile is computed. If the 50th distinct consecutive price is among the 75% most observed prices then it is regarded as significant. The procedure is then repeated for the following 100 distinct prices with an overlap of 99 prices, so that it is a "rolling" procedure. It is this rolling nature of the procedure that allows the cut-off frequency to vary.

Once the set of significant prices has been determined, in a second step *empirical psychological prices* are defined as significant prices with 9, 95 or 98 as last digit(s)[4], and *empirical fractional prices* are defined as the remaining significant prices that are divisible by 5 BEF. Other significant prices are regarded as ordinary.

The disadvantage of using this procedure is that the first and the last 50 distinct prices are excluded from the definition of significant prices. This is not too awkward for the last 50 distinct prices because their relative importance is very low, and because the impact of rounding on large prices is proportionally insignificant.[5] The problem is more acute for the first 50 distinct prices. A solution then is to add *extrapolated psychological prices* and *constructed fractional prices* for amounts below 51 BEF. In practice we added the following psychological prices: 9, 19, 29, 39, 49; and the following fractional prices: 1, 2, 3, 4, 5, 6, 7, 10, 11, 14, 15, 16, 17, 20, 21, 22, 24, 25, 26, 30, 31, 32, 35, 36, 40, 41, 44, 45, 46, 47 and 50. The latter series of prices corresponds to all non-psychological prices

[4] Although from a theoretical point of view prices ending with 95 and 98 should not be regarded as psychological, empirical data show that these prices are frequently used and can be compared to psychological prices, especially for higher BEF prices. Folkertsma (2001) makes the same deviation from theory.

[5] When round prices are also considered in the analysis, the last 50 prices can be, and generally are, regarded as round prices.

Table 2 - Frequency of attractive prices, using different definitions of psychological and fractional prices

TYPE	Description	Unweighted (a)	Weighted (b)
I. Empirical psychological and fractional prices	All significant prices which are psychological or fractional. Extrapolated psychological and constructed fractional prices for amounts under 51BEF.	69.9	61.9
II. Empirical psychological and constructed fractional prices	Psychological prices as in I. Constructed fractional prices replace empirical fractional prices.	71.8	62.7
III. Including round prices	As II, but including all round prices (multiples of 100).	72.7	64.7
IV. Prices ending with 0, 5, 9, 95 or 98	All prices ending with 0, 5, 9, 95 or 98.	72.0	68.0

Source: NBB.
(a) As a percentage of the 106,159 observed prices for January 2000.
(b) Percentage of the observed prices by item, aggregated using the CPI weighting coefficients (680.8/1,000 covered).

below 51 BEF for which a payment can be made with three or fewer coins or notes with no change or only one coin or banknote in change.

This defines our first set of attractive prices (*type I* in Table 2), which represents 69.9% of all observed prices in the December 2000 database. When CPI weights are used, this first set of attractive prices represents 61.9% of the prices in the database[6].

With respect to the definition of this set of attractive prices several problems can be mentioned.

First, it is not certain whether the set of psychological and fractional prices is complete. Missing psychological and fractional prices could distort the analysis. As proposed in Folkertsma (2001), a solution could be to add *theoretical psychological prices* for prices below 200 BEF and construct a complete set of *theoretical fractional prices*. The

[6] The weighted share does not fully correspond to the weighted share of attractive prices in the NICP, because the database only covers 68.1% of the CPI (unless one assumes implicitly that the missing items represent the same proportion of attractive prices as the calculated weighted share, which is unlikely).

set of psychological prices remained unchanged, however, because all theoretical psychological prices below 200 BEF had already been selected. Only the set of fractional prices was altered, by replacing *empirical fractional prices* by *constructed fractional prices.* As before, this is done by defining fractional prices as those prices for which a payment can be made with three or fewer coins or notes with no change or only one coin or note being needed for change. This defines our second set of attractive prices (*type II* in Table 2). On the basis of this definition attractive prices represent 71.8% of all observed prices, and when the CPI weights are used this share amounts to 62.7%

A second problem is that the special role of round prices is ignored. Some prices regarded as fractional could instead be round prices. Augmenting the second set of attractive prices with all round prices defines our third set (*type III* in Table 2). We assumed that round prices are multiples of 100[7] for prices above 500 BEF. According to this definition, 72.7% of unweighted NICP prices and 64.7% of weighted NICP prices are attractive prices.

Finally, we constructed a last set of attractive prices (type IV). In this set, attractive prices are defined on basis of the last digits of each price only, without taking the frequency distribution of the prices into account. All prices ending with 9, 95 or 98 are defined as psychological, all prices ending with 0 or 5 are regarded as fractional. Round prices are again multiples of 100, for amounts above 500 BEF. This set represents 72.0% of all recorded prices and 68.9% for weighted data.

A breakdown by product category (Table 3) shows that attractive prices are the most widely used for *Clothing and footwear* (Coicop 03), and *Restaurants and hotels* (Coicop 11). For the largest category in the CPI, *Food and non-alcoholic beverages* (Coicop 01) a fairly large amount of attractive prices was recorded as well. On the other hand, attractive prices are less used for *Tobacco* (Coicop 02), *Health* (Coicop 06), *Housing, water, electricity, gas and other fuels* (Coicop 04) and *Transport* (Coicop 07).

[7] Folkertsma (2001) takes all NLG prices without decimals into account, which means that the minimum distance between two round prices is about 5 times smaller in NLG than in BEF.

Table 3 - Attractive pricing by product category (December 2000)

Coicop code	Description	Coverage of the database	Attractive prices I		Attractive prices II		Attractive prices III		Attractive prices IV (0 5 9)	
		total *(per mille)*	number	per cent	number	per cent	number	per cent	number	per cent
01	Food and non-alcoholic beverages	213.9	42,329	69.4	45,441	74.5	45,441	74.5	38,661	63.4
02	Tobacco	13.2	34	3.1	450	41.3	450	41.3	46	4.2
03	Clothing and footwear	82.0	9,250	84.8	8,953	82.0	9,069	83.1	10,616	97.3
04	Housing, water, gas, electricity	41.2	682	33.1	720	35.0	832	40.4	1,187	57.7
05	Furnishing & maint. of housing	86.1	8,563	73.4	7,154	61.3	7,562	64.8	10,028	85.9
06	Health care expenses	8.5	226		184	42.7	184	42.7	316	73.3
07	Transport	65.2	832	30.2	732	26.6	792	28.7	1,267	46.0
08	Communications (a)	0.6	73	84.9	23	26.7	25	29.1	84	97.7
09	Leisure and culture	64.0	6,089	78.5	5,689	73.3	5,774	74.4	6,685	86.2
10	Education	-	-	-	-	-	-	-	-	-
11	Hotels, cafés and restaurants	63.8	2,191	72.2	2,685	88.5	2,746	90.5	2,889	95.2
12	Miscellaneous goods and services	42.5	3,893	72.3	4,235	78.6	4,341	80.6	4,618	85.7
00	**Total (NICP)**	681	74,162	**69.9**	76,266	**71.8**	77,216	**72.7**	76,397	**72.0**
	Weighted result (b)			**61.9**		**62.7**		**64.7**		**68.9**

(a) Only fax machines are covered in the database used under the Communications category.
(b) Percentage of the observed prices by item, aggregated using the CPI weighting coefficients (680.8/1,000 covered)

2.3. Definition of attractive prices in euro

Attractive prices expressed in BEF give hardly any information on attractive prices in euro. It is very likely that euro attractive prices will make extensive use of decimals, whereas decimal pricing is not a common practice in BEF. In the December 2000 database, only 2.8% of the prices had decimals, the bulk of these being petrol prices. To solve this problem we have used NLG *empirical psychological prices* calculated by Folkertsma (2001)[8] as an approximation for *empirical euro psychological prices* because NLG prices are expressed with decimals.

[8] We would like to thank C.K. Folkertsma for providing us with the set of empirical psychological NLG prices which he calculated.

Fractional prices have been constructed following the same definition as for BEF constructed fractional prices (prices for which a payment can be made with three or fewer coins or notes with no change or only one coin or banknote in change). *Round* euro prices have been defined as multiples of 5 euro[9].

2.4. Simulation scenarios and results

Once attractive prices have been identified in BEF as well as in euro, it becomes possible to test various changeover scenarios with different rounding hypotheses. The aim of this study being the computation of a worst-case scenario, we make the following assumptions:

- prices are always rounded up;
- ordinary prices[10] are rounded up to the next cent (for instance 416 BEF, or 10.3124 euro, is rounded to 10.32 euro);
- psychological, fractional and round prices are rounded up to the next attractive euro price of the same type (because the different types of prices are chosen for different reasons);
- no effects other than rounding are taken into account: suppliers do not take account of the price effect on the demand for their products, and indirect price effects (through wages for instance) are ignored;
- we assume that in December 2000 attractive pricing was still done exclusively in BEF and that the database was free of euro-rounding effects which had already occurred.

The magnitude of euro-rounding effects on inflation depends on how attractive prices are defined. We therefore tested the following scenarios based on the definitions discussed in the previous sections, to which we added rounding assumptions.

[9] Instead of prices without decimals as in Folkertsma (2001). Note that the BEF definition of round prices also differs from the definition in the Dutch study.

[10] Decimal prices in BEF found in the database (mainly petrol prices) are assumed not to be attractive and are simply converted in accordance with official rules (these prices represent less than 3% of the total).

Scenarios

A. In ***Scenario A*****,** *empirical psychological* and *empirical fractional prices* (type I) are used to determine whether a price denominated in BEF is actually psychological or fractional. After that, *empirical psychological euro prices* and *constructed fractional euro prices* are used to construct the corresponding rounded prices in euro. Because empirical fractional prices higher than 60,510 BEF (1,500 euro) have no constructed fractional price equivalent in euro (since the highest constructed fractional price is equal to 1,500 euro or three 500-euro notes), they are rounded to the next euro. This scenario is similar to Scenario 2 in Folkertsma (2001).

B. ***Scenario B*** uses definition II of attractive prices (*constructed instead of empirical fractional prices* are considered). The same approach as in Scenario A (*empirical psychological* and *constructed fractional* prices) is used to construct the corresponding rounded prices in euro. This scenario is similar to Scenario 3 in Folkertsma (2001).

C. ***Scenario C*** is an extension of Scenario B in order to allow *round prices* to play a separate role (as in definition III of attractive prices). All multiples of 100 above 500 BEF that are not defined as fractional are rounded up to the nearest round euro price.

D. Finally, ***Scenario D*** tests whether the use of a simplified definition of attractive prices (type IV) makes a difference. Euro prices are rounded as in C. In addition, all non-round prices higher than 1,500 euro are rounded up to the next euro for the same reason as in Scenario A.

Table 4 - Simulation results of the worst-case scenario (based on December 2000 data)

4.1 Results for the products in the database (68.1 % of NICP)

Coicop code	Description	Scenario A	Scenario B	Scenario C	Scenario D
		percentage change	percentage change	percentage change	percentage change
01	Food and non-alcoholic beverages	1.21	1.25	1.25	1.23
02	Tobacco	0.25	0.25	0.25	0.25
03	Clothing and footwear	0.66	0.55	0.60	1.18
04	Housing, water, gas, electricity	0.55	0.57	0.57	0.80
05	Furnishing and maintenance of housing	0.59		0.46	0.68
06	Health care expenses	0.24	0.19	0.19	1.40
07	Transport	0.19	0.17	0.18	0.27
08	Communications	0.44	0.14	0.14	0.55
09	Leisure and culture	0.68	0.62	0.64	0.76
10	Education				
11	Hotels, cafés and restaurants	0.41	0.46	0.46	0.61
12	Miscellaneous goods and services	0.61	0.60	0.62	0.87
00	**Unweighted result**	0.86	0.82	0.84	1.02
	Weighted result, but partial (a)	0.73	0.71	0.72	0.89

(a) Result by item, aggregated using the CPI weighting coefficients (680.82/1,000 covered).

4.2 Extrapolation of the results to the whole NICP

Coicop code	Description	Scenario A	Scenario B	Scenario C	Scenario D
		percentage change	percentage change	percentage change	percentage change
01	Food and non-alcoholic beverages	1.21	1.25	1.25	1.23
02	Tobacco	0.25	0.25	0.25	0.25
03	Clothing and footwear	0.66	0.55	0.60	1.18
04	Housing, water, gas, electricity	0.15	0.16	0.16	0.22
05	Furnishing and maintenance of housing	0.59	0.43	0.46	0.68
06	Health care expenses	0.24	0.19	0.19	1.40
07	Transport	0.19	0.17	0.18	0.27
08	Communications	0.01	0.00	0.00	0.02
09	Leisure and culture	0.63	0.59	0.61	0.72
10	Education	0.68	0.62	0.64	0.76
11	Hotels, cafés and restaurants	0.40	0.45	0.45	0.64
12	Miscellaneous goods and services	0.40	0.39	0.40	0.57
00	**Total (NICP) weighted result**	0.56	0.54	0.55	0.72

Results

The upper level of Table 4 presents the simulation results[11] for the products in the database (i.e. 68.1% of total NICP). Using some additional assumptions regarding the rounding behaviour for the missing products, the results were extrapolated in order to obtain an estimate of the total effect on the NICP. These assumptions can be summarised as follows:

- for *Actual rentals for housing*, *Electricity*, *Natural gas*, *Telephone and telefax services*, *Insurance*, *Postage stamps*, *Education* and *Mortgage fees* (representing together 15.6% of the NICP) it was assumed that the practice of attractive pricing and hence the risk of rounding up is not relevant;
- for *Magazines* and *Newspapers* (Coicop 09.3.2.0.01 and 09.3.2.0.02, representing 1.05% of the NICP weights) we assume that pricing (and hence the impact of rounding) is similar (extensive use of small amounts and fractional prices) to pricing for Cafes (Coicop 11.1.1.3.00);
- for the remaining products (15.4% of the NICP) it was generally assumed that the impact of rounding corresponds to the average impact of the closest category to which they belong.

Leaving Scenario D aside, the worst-case impact of rounding on inflation should be somewhat lower than 0.6%, regardless of the scenario considered. This means that differences in the first three definitions of psychological prices are of minor importance and that round prices play only an insignificant additional role. This is consistent with the result of Folkertsma (2001). However, the maximum effect is somewhat smaller in Belgium than in the Netherlands. This can presumably be attributed to the fact that the proportion of attractive prices in BEF is smaller than the corresponding proportion in NLG, and to the fact that there are more distinct prices available in euro than in BEF (thus reducing the absolute price change needed to reach the next attractive price), whereas this is not the case for NLG.

In Scenario D, based on a non-empirically defined set of attractive prices, the maximum effect on inflation is a little higher and amounts to 0.72%.

[11] For each product in the database, an average price has been computed as the average of observed prices expressed in a common unit (per litre, per kilo, per piece...). This has been done first using BEF prices converted into euro applying the official conversion rule and then using BEF prices rounded into euro according to the various scenarios. Indices have then been computed for each product as the ratio of the rounded euro price to the non-rounded euro prices. After that, the weighted index has been computed using the NICP weights for each product.

Caveats

It should be remembered that the various scenarios described constitute a purely hypothetical exercise in the sense that, based on economic arguments, it is very unlikely that the worst-case scenario tested here will in fact occur in practice. It can indeed be expected that competition on product markets, as well as the current slowdown of economic activity, reduces the risks that all firms will round their prices up. The vigilant attitude of consumers and the fact that the changeover is closely monitored by consumer organisations, as well as by the Economic Inspection of the Ministry of Economic Affairs, is a third factor which reduces the likelihood of systematic rounding up.

In this connection we wish to emphasise that the largest rounding effect (1.21%) was obtained for the largest Coicop category, *Food and non-alcoholic beverages*. This is due to the fact that this category combines the following two properties: (i) there is a widespread practice of attractive pricing, and (ii) there are many relatively low prices in this category for which proportionally large rounding effects are obtained. All in all, the contribution of this category to the total effect is substantial and amounts to 0.25 percentage points. However, precisely for this product category other sources tend to provide evidence that the impact of rounding will be limited. The following points can be made in this connection:

- the predominance of supermarkets for these products and the growing share of "discounters" lead to a high degree of price competition which reduces the scope for upward rounding substantially;

- Fedis (the Belgian Federation of Distributors, comprising retail and wholesale traders, especially supermarkets) announced unilaterally that its members would ensure a high degree of price stability by converting prices without rounding or by rounding prices down and that, if some prices increased, the aggregate price level would not be affected[12]. Other organisations representing the Belgian enterprise sector made similar commitments;

[12] See www.fedis.be.

- results from the Bank's euro survey[13] seem to confirm this intention. They suggest that retail market companies are generally not planning to introduce price increases when converting to the euro. The individual answers show that 32% plan to convert their prices strictly in accordance with the conversion rules; 53% claim that they will round prices up and down, with an overall neutral effect; while 5% suggest that they will round prices down, against 6% that will round up. Extrapolating these results to the entire sector increases the weight given to the larger companies (supermarkets in particular), thereby considerably magnifying the likelihood of rounding *down*: 36% strict conversion, 31% globally neutral and 25% rounding down against 5% rounding up.

The reader should also be made aware of a number of the characteristics of the definitions used above which have an impact on the total effect obtained:

- using NLG psychological prices as an approximation for euro psychological prices implies that fewer distinct psychological prices were used than the number that will probably appear in euro. Indeed the distance between two distinct psychological prices in euro is approximately twice as large as the distance between two consecutive NLG prices. Consequently, simulations based on these prices are likely to overestimate the impact of rounding;

- round prices have been defined as multiples of 5 in euro and of 100 in BEF, implying that the distance between two consecutive round prices in euro is more than twice as great as in BEF, thus probably causing the effect of rounding round prices to be overestimated;

The above-mentioned technical details of the definitions used tend to result in overestimation of the impact of rounding, which is consistent with simulating the worst-case scenario. There is however one factor which may work slightly in the opposite direction. This has to do with the definition of fractional prices. Indeed, since there are more different coins/notes in euro than in BEF, the probability that someone has the right three coins/notes to make the payment is lower on the assumption that the payer has an identical number of notes/coins. Simple payments in euro thus require possession of more coins/notes than those in BEF, which could be seen as less convenient.

[13] Survey conducted in August 2001, National Bank of Belgium (2001).

3. LESSONS FROM THE 1992 VAT RATE CHANGES

After having quantified the worst-case scenario in the previous section, it is natural to wonder how likely this scenario is. This is precisely the question which is addressed in this section. It therefore focuses on the analysis of the price effects of the April 1992 VAT rate change in order to find empirical evidence of rounding effects and indications on the time span involved. Such information is expected to help in assessing the likelihood of the worst-case scenario.

Again this analysis makes extensive use of the individual price database built up by the Ministry of Economic Affairs for computing the consumer price index, essentially the March - April 1992 subsample.

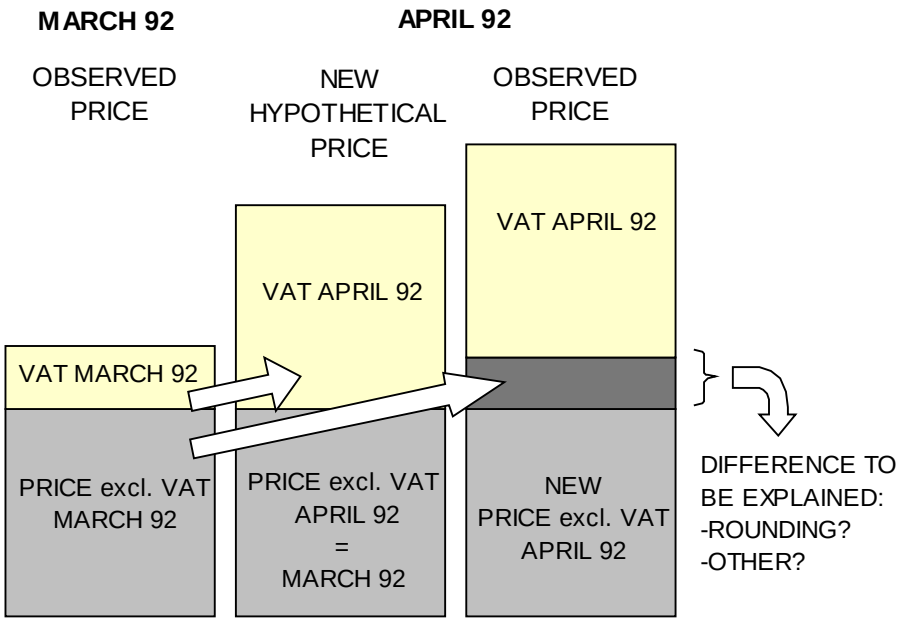
3.1. The approach adopted: a case study of the 1992 VAT rate changes

The study of price effects after VAT changes is based on the following idea. When VAT changes are strictly applied, all other things being equal, the new resulting (hypothetical) price – referred to from here on as the *new hypothetical price* - is hardly ever a price of the same "type" as the original one. It should be noted that the price type refers to whether prices are attractive or not (ordinary) and that attractive prices are defined here as type IV attractive prices in the previous section[14]. Comparing the price actually observed after the VAT change with the *new hypothetical price* can yield information on how attractive and ordinary prices have been rounded.

The most substantial VAT rate change in recent years, with a broad effect on various products, took place in April 1992, within the framework of the European VAT harmonisation. The analysis presented in this section is a case study of this event and is therefore essentially based on prices recorded during the months of March 1992 (when the old rates were in application) and April 1992 (when the new rates were introduced). More precisely, the *new hypothetical prices* are calculated by applying the new VAT rates to the March 1992 prices net of VAT, while the prices actually observed after the VAT rate change correspond to the April 1992 prices, as is illustrated in Figure 4.

[14] This means that all prices ending with 0, 5, 9 or 98 are regarded as attractive prices, among which all prices ending with 9, 95 or 98 are psychological prices and all other prices ending with 5 or with 0 are fractional or round prices (without any distinction being made between the latter two types).

Figure 4 - Analysis of the VAT rate changes



In 1992, 7 different types of VAT rate changes occurred in Belgium, as is shown in Table 5. Three changes entailed a rate reduction, while the other four changes were rate increases. The changes ranged from VAT rate *reductions* of 13.5 percentage points (from 33% to 19.5%) to VAT rate *increases* of 13.5 percentage points (from 6% to 19.5%). In total we considered 233 different products from the database for which the VAT rate changed. This represents 28,105 prices observed in March and in April (constant sample). To control for changes in the quantity of a product (packaging changes) we excluded 143 observed prices (belonging to 31 different product categories). This relatively low rate of packaging changes is somewhat unexpected, as it is often said that the technique of packaging change, i.e. an increase or decrease in the quantity of the product per unit sold, could be used to solve the price-setting problem (attractive prices). This can probably be explained by the very short time period under review and/or by the fact that hardly any food products are included in the analysis.

Table 5 - Description of the VAT rate changes

TYPES	VAT rate March 1992	VAT rate April 1992	VAT rate change (in percentage point)	Implied price variation (in %)	Number of products affected within the database	Corresponding number of observed product prices
I	33	19.5	-13.5	-10.15	11	332
II	19	12.0	-7.0	-5.88	4	1,423
III	25	19.5	-5.5	-4.40	39	3,194
IV	19	19.5	0.5	0.42	119	15,033
V	17	19.5	2.5	2.14	45	4,078
VI	6	12.0	6.0	5.66	6	1,154
VII	6	19.5	13.5	12.74	9	2,891
Total	-	-	-		233	28,105

Although there is undoubtedly some analogy between euro rounding effects and comparing *new hypothetical prices* with actually observed prices after a VAT rate change, the reader should be aware of the following caveats:

- as shown in Table 5, the magnitude of the April 1992 VAT rate changes differed from one product to another. This implies that relative prices were affected, whereas the cash changeover, apart from differences in rounding behaviour, should leave relative prices unchanged. Moreover, a VAT rate change in one country affects relative prices at the European level, whereas the changeover does not;

- the impact of VAT rate changes is relatively more important for final consumption than for intermediate consumption, whereas the changeover should affect both to the same extent;

- rounding effects observed are in BEF, without decimals, whereas we would be interested in euro prices with the cent element;

- data from 1992 are nine years old, which means that substantial structural changes, for instance in the price-setting strategy, may have occurred. As a result, extrapolation of the results to the situation currently prevailing should be done with caution;

- the case study is essentially based on only two months, which excludes from the analysis any longer-term adjustment (prior to or after the VAT change). Moreover,

even between two consecutive months many factors other than the VAT rate changes (that were not taken into account here) may have influenced the observed prices;

- finally, food products are hardly represented at all in the sample, because they were not affected by VAT changes. However this category has a large weight in the CPI and was identified in the previous section as the product category for which the worst-case scenario presented the greatest theoretical risk of rounding effects (up to 1.21 %).

These caveats show that it is not an easy task to derive estimates of the magnitude of rounding effects and to extrapolate these results to the euro cash changeover. Isolating rounding effects from other factors affecting the observed prices is particularly difficult. Hence, the results presented below only provide some rough indications. Obviously, any ex post assessment of the cash changeover will face the same difficulties[15].

3.2. Indications of the magnitude of rounding effects

3.2.1. Results based on the entire constant sample affected by VAT rate changes between March and April 1992

Table 6 presents the results of comparing the *new hypothetical prices* with the prices actually observed after the VAT rate change. In the first instance total results are presented on the basis of an *unweighted* average of all 28,105 price combinations for the two months considered.

The most striking result is that the average deviation (column 7) is negative and amounts to - 0.21%. This means that, on average, the combined result of rounding effects induced by the tax change and regular price adjustments (net of VAT) has been negative. On the assumption that, with positive inflation, the effect of regular price adjustments should in principle be positive, this result suggests that the tax change has not been used to increase prices unduly – on the contrary. Positive deviations from the *new hypothetical price* (3.22 % on average) tend to be larger than negative deviations (-1.56 % on average). The net effect is however negative, given the predominance of negative deviations (72.9 % as opposed to 25.8 % for positive deviations).

[15] Other studies relating to the cash changeover face the same problem and do not present a clear-cut solution either. See for instance: Ville Aalto-Setälä (2001) and Statistisches Bundesamt (2001).

Table 6 - Price effects of the 1992 VAT rate changes

	TOTAL								
	Number of prices for which the VAT rate changed		Distribution of observations according to the type of price adaptation (a)				Percentage deviation from the *new "hypothetical" price* (Unweighted average)		
	Nbr.	% of total	Total	Pob>Pnh *(a)*	Pob<Pnh *(a)*	Pob=Pnh *(a)*	TOTAL	Pob>Pnh *(a)*	Pob<Pnh *(a)*
	1	% of (a)	6 = (3) +(4)+(5)	3	4	5	7	8	9
Total	28105	100.0	100	25.8	72.9	1.2	**-0.21**	3.22	-1.56
By price type									
A. Psy-Psy	5714	20.3	100	9.8	90.0	0.2	**-0.73**	3.94	-1.26
B. Frac-Frac	11103	39.5	100	23.6	75.0	1.4	**0.04**	3.84	-1.34
C. Ord-Ord	5932	21.1	100	16.8	80.9	2.2	**-0.74**	4.10	-1.87
D. Frac & Psy	1832	6.5	100	60.0	39.5	0.5	**0.45**	2.41	-2.66
E. Mixed	3524	12.5	100	56.4	42.7	0.9	**0.39**	2.20	-2.33
By VAT change type									
Type I (-13,5 pts)	332	1.2	100	59.0	41.0	0.0	**-0.07**	0.75	-1.24
Type II (-7 pts)	1423	5.1	100	51.5	47.6	0.8	**0.67**	2.90	-2.07
Type III (-5,5 pts)	3194	11.4	100	65.0	35.0	0.0	**1.04**	2.54	-1.75
Type IV (0,5 pts)	15033	53.5	100	12.5	86.3	1.3	**-0.11**	4.14	-0.79
Type V (2,5 pts)	4078	14.5	100	26.6	70.9	2.5	**0.40**	5.41	-1.98
Type VI (6 pts)	1154	4.1	100	7.8	91.5	0.1	**-4.03**	1.00	-4.50
Type VII (13,5 pts)	2891	10.3	100	41.8	56.9	1.3	**-1.91**	1.74	-4.77

(a) Pob is the observed price in April 1992, Pnh is the *new hypothetical price* (exact price which would have prevailed if only the VAT rate changed)
Pob>Pnh: refers to observed prices in April that are greater than what the VAT rate change would require
Pob<Pnh: refers to observed prices in April that are smaller than what the VAT rate change would require
Pob=Pnh: refers to observed prices in April that corresponds to the price that the VAT rate change requires (when the latter is not rounded)

This predominance of small negative deviations can be worrying from the point of view of the "psychological" aspects of the euro changeover (at the core of economic agents' expectations), because it has been seen from anecdotal evidence in the press that price increases are causing greater anxiety and also tend to be attributed entirely to the euro. A few large price increases, although more than compensated for by many smaller unnoticed price falls, might give the wrong signals to consumers.

To allow a clear-cut distinction to be made concerning the contribution of attractive prices to the results a more refined breakdown of these is necessary.

Therefore, in a second step, results were broken down according to two types of classification. The first classification relies on the price characteristics. With three types of prices (psychological, fractional and ordinary) in each of the two months considered, nine types of price combinations for the two months are theoretically possible. We consider three of them explicitly, more particularly the combinations where prices were psychological in the two months (Type A "Psy-Psy" in Table 6), the combinations where prices were fractional in the two months (Type B "Frac-Frac" in Table 6) and the combinations where prices were ordinary in both months (Type C "Ord-Ord" in Table 6). Those three types of price combinations apply to 5,714, 11,103 and 5,932 observations respectively, or the bulk (81 p.c.) of the total number of combinations considered in the constant sample. This seems to confirm that prices continue to belong to the same category even after a major shock such as the April 1992 VAT rate change. It is precisely this phenomenon that is at the heart of euro-rounding concerns. The six other theoretical combinations are, for simplicity's sake, grouped in two broader categories: the combinations constituted by a psychological price in one month (regardless of which month of the two considered) and a fractional price in the other month (Type D "Frac & Psy" in Table 6) and the combinations constituted by an attractive price (either psychological or fractional) in one month (regardless of which month of the two considered) and an ordinary price in the other month (Type E "Mixed" in Table 6). The latter two categories represent 1,832 and 3,524 observations respectively.

The net contribution of the different types considered to the total result is difficult to interpret in terms of attractive versus non-attractive pricing. Prices that were psychological in both months (type A) contributed negatively, but this was also observed for prices that were ordinary in both months (type C). For fractional prices (type B) the deviation between new hypothetical prices and prices actually observed was very small,

while it was substantially positive for the two groups where the price type changed from one month to the other (types D et E).

A second classification is based on the 7 types of VAT rate changes described in Table 5. According to this breakdown, the total negative result is attributable to increases in VAT rates that were not completely incorporated in the prices actually observed (types IV, VI and VII). VAT rate reductions were not completely passed on either (types II and III) and this phenomenon worked in the opposite direction. Overall, these results do not reveal a systematic upward or downward bias, but they do reflect a definite reluctance of price-setters to pass on VAT rate changes (increases as well as decreases) completely and/or immediately. Concerns about their relative prices, which have an impact on the demand for the products they sell, may underlie this reluctance of price-setters. However, the main reason seems to be the fact that a substantial proportion of the prices in question did not change immediately. That is why the next section distinguishes between prices that changed between March and April 1992 and prices that did not change.

3.2.2. Results for a subset of prices that are affected by the VAT rate changes and that actually changed between March and April 1992

As can be seen from Table 7 (column 2), 60% of the prices in the constant sample did not change between March and April 1992, notwithstanding the VAT rate changes. This observation suggests a considerable degree of short-run price stickiness, even in the event of a major VAT shock. However, in line with state-dependent forms of price stickiness - such as for instance the presence of fixed menu costs -, the proportion of prices that did not change is considerably smaller for the products for which the VAT rate change is substantial, particularly Types I, II and III for VAT rate reductions and Type VII for VAT rate increases. It was for instance found that for 25% of the prices considered the price change entailed by the VAT rate changes was less than 1 BEF. This phenomenon was particularly significant in the case of small VAT rate changes: for Type IV it applied to 6,301 prices (or 42% of the number of observations for that type) and for type V to 662 prices (or 16% of the number of observations for that type). Furthermore, these proportions do not reveal a greater reluctance to change prices in the case of VAT rate reductions than in the case of VAT rate increases.

Table 7 - Price effects of the 1992 VAT rate changes (Part II: prices that changed between March and April)

	TOTAL (nbr of prices for which the VAT rate changed)	Prices that did not change	Prices that changed				
			Total	Distribution of observations according to the type of price adaptation			Percentage deviation from the new "hypotetical" price
	Total (%)	Total (%)	Total (%)	Pob>Pnh (a)	Pob<Pnh (a)	Pob=Pnh (a)	
	1 = (2)+(3)	2	3 = (4)+(5)+(6)	4	5	6	7
Total	100.0	60.0	40.0	22.5	16.3	1.2	**0.8**
By price type							
A. Psy-Psy	100.0	86.6	13.4	6.3	6.9	0.2	0.0
B. Frac-Frac	100.0	70.7	29.3	18.5	9.4	1.4	1.8
C. Ord-Ord	100.0	68.5	31.5	14.0	15.3	2.2	0.6
D. Frac & Psy	100.0	0.0	100.0	60.0	39.5	0.5	0.4
E. Mixed	100.0	0.0	100.0	56.4	42.7	0.9	0.4
By VAT change type							
Type I (-13,5 pts)	100.0	0.9	99.1	58.1	41.0	0.0	-0.2
Type II (-7 pts)	100.0	11.0	89.0	40.5	47.6	0.8	0.0
Type III (-5,5 pts)	100.0	24.1	75.9	40.9	35.0	0.0	-0.1
Type IV (0,5 pts)	100.0	80.8	19.2	12.5	5.5	1.3	1.3
Type V (2,5 pts)	100.0	62.9	37.1	26.6	8.0	2.5	4.6
Type VI (6 pts)	100.0	70.3	29.1	7.8	21.2	0.1	-0.9
Type VII (13,5 pts)	100.0	14.1	85.9	41.8	42.8	1.3	-0.4

(a) Pob is the observed price in April 1992, Pnh is the *new hypothetical price* (exact price which would have prevailed if only the VAT rate changed)
Pob>Pnh: refers to observed prices in April that are greater than what the VAT rate change would require
Pob<Pnh: refers to observed prices in April that are smaller than what the VAT rate change would require
Pob=Pnh: refers to observed prices in April corresponding to the price that the VAT rate change requires (when the latter is not rounded)

What does this mean for an assessment of rounding effects? First of all, it seems to suggest that even in the event of a VAT rate shock normal economic phenomena, such as a menu-cost-based price stickiness, continue to play their role. This in fact confirms the conclusion reached above that the VAT rate change was not used to change prices unduly. Second, it confronts us with a major extrapolation problem, as letting unchanged listed BEF prices is clearly not a valid option for the cash changeover. We therefore present below results which are based on the subsample of prices that actually changed.

Distinguishing between prices that changed and those which did not change between March and April 1992 reveals that the result of Table 6, where it was found that a substantial proportion of prices were in the same category in both months (types A, B and C), is to a great extent due to the prices that do not change. As a matter of fact, of all the prices that were psychological (type A), fractional (type B) or ordinary (type C) in both months, only 13.4%, 29.3% and 31.5% respectively, actually changed .

In contrast to the result based on the complete sample (subsection 3.2.1), the deviation between the new hypothetical price and the price actually observed is positive when we concentrate only on prices that did change. For these prices the deviation amounts to 0.8%.

Is a deviation of 0.8% suggestive of a substantial rounding-up effect ? This is difficult to assess, as this figure also incorporates the effect of regular price changes between March and April 1992. Although it is not possible precisely to isolate the latter type of price changes from rounding effects, the following elements may help to make such an assessment:

- between 1990 and 2001, the average variation between April and March in the prices of the 233 products that have been directly affected by the 1992 VAT rate change ranges from 0.0% (in 1996 and 1997) to 2.2% (in 1995). The average for that period, excluding the year 1992, amounts to 0.4%, while the standard deviation is 0.6%. Hence a confidence interval of 2 standard deviations around this average has 1.6% as the upper limit. Our observed deviation does not exceed this upper limit and can therefore be regarded as a normal magnitude for the impact of regular price changes, suggesting that the effect of rounding would have been rather marginal. This is even more true if we take into account the fact that the calculated deviation from new hypothetical prices

was influenced upwards between March and April 1992 by an increase in excise duties on petrol and diesel, a factor for which we did not allow for in our analysis;

- another approximation to the regular price changes can be obtained by focusing on the average deviation of ordinary prices (Type C). Indeed, as ordinary prices are not set on the basis of the attractiveness of prices, their evolution should in principle only reflect the impact of regular price changes (inasmuch as price changes of this type affect all product categories in the same way). In Table 3, the percentage deviation from the new hypothetical price of Type C prices amounts to 0.6%. Again, this figure is very close to the 0.8% obtained above;

- the positive deviation seems largely attributable to relatively small shocks (Types IV and V). In the presence of menu costs, this should not be surprising. We have already seen that it can be optimal in the case of a small shock not to adapt prices because the marginal gain of a price change could be less than the menu cost which has to be borne when prices are changed, which explains the large number of unchanged prices for small shocks. When prices are nevertheless changed in response to such a small shock, it suggests that firms were pulled outside their range of inaction, either because they catch up shocks that have not been passed on yet or anticipate future shocks. This type of clustering of price changes leads typically to the largest percentage deviation from new hypothetical prices for the smallest VAT rate shocks;

- another explanation of the greater contribution of small shocks to the deviation is that for an identical absolute deviation (additional price change - in absolute terms - needed to attain an attractive price) the relative deviation will be larger in the case of small VAT changes than in the case of larger ones. This effect is also greater for low prices.

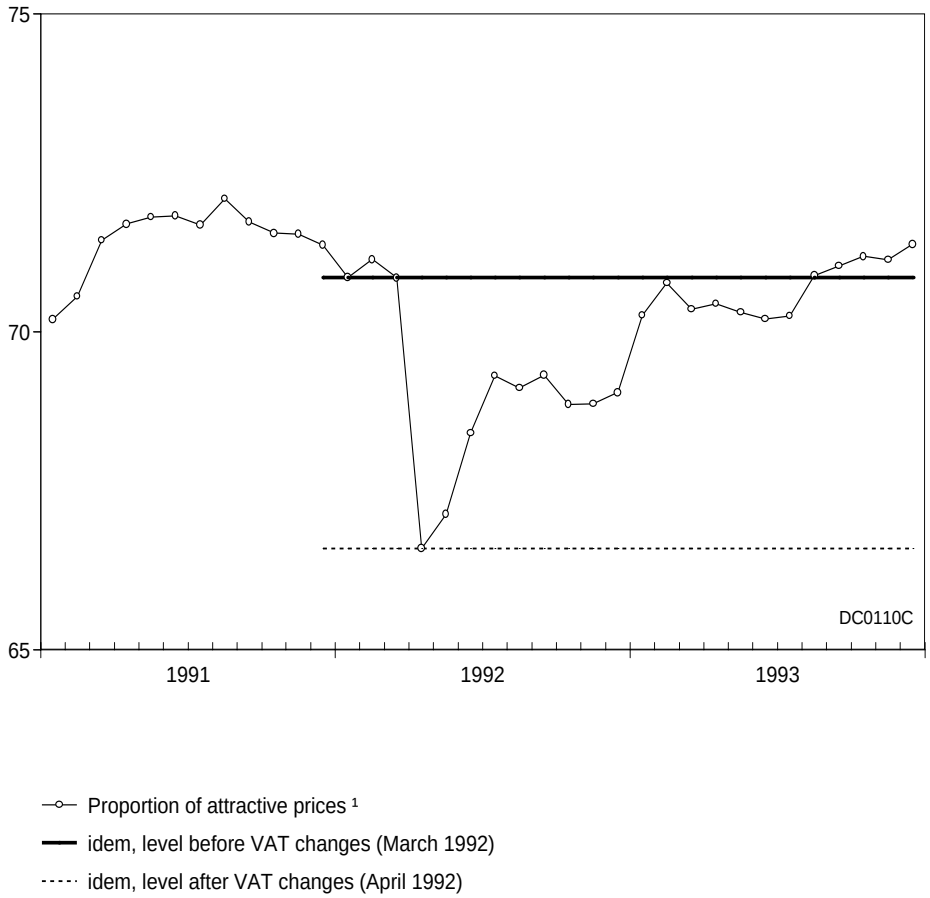
Concerning the role of attractive prices, we observed a relatively large positive contribution of fractional prices, (Type B) to the global deviation. This contrasts with the zero contribution from psychological prices (Type A), which in fact corresponds to a net negative contribution when allowance is made for regular price changes, which are assumed to be strictly positive in a context of positive inflation.

3.2.3. *Evolution of the proportion of attractive prices after the VAT rate change of April 1992*

The analysis of rounding effects would also benefit from information on the timing of the effects. By construction, the worst-case scenario does not give any information on the time span involved and it is very unlikely that rounding effects will be concentrated in January 2002. This aspect is however hard to evaluate because of all the other factors influencing prices. An indication, which is far from perfect, could nevertheless be obtained from the evolution of the number of attractive prices during the months following the April 1992 VAT rate change. Figure 4 shows the evolution of the proportion of attractive prices (again type IV of the previous section) in the total number of prices for the products experiencing a VAT rate change. Prices do not seem to have been adjusted prior

Figure 4 - Evolution of the proportion of attractive prices[1] among products undergoing VAT changes in April 1992

(percentages)



[1] Defined as prices with 0, 5, 9 or 98 as last digit(s).

to the VAT change. However, immediately following the VAT change it can be seen that the proportion of attractive prices declined by 6%, which means that the vast majority of attractive prices (roughly speaking 94% of them) were adjusted and adapted immediately or did not change. The time span needed to go back to the proportion of attractive prices prevailing before the VAT rate change can be estimated at roughly 11 to 17 months. However, the adaptation process itself remains largely unknown.

It is difficult to extrapolate these results to the euro cash changeover because the nature of the required adaptation is different. First, in the case of the changeover *all* prices must, by law, have been converted by 1 January 2002 at the latest, requiring all prices to be adapted, which creates an opportunity to adapt the price strategy by rounding attractive prices. Second, unlike a VAT rate change, adaptations before the deadline are very likely. It therefore seems reasonable to assume that the adjustment of attractive prices will start before the changeover.

4. GENERAL CONCLUSIONS

Attractive prices, usually defined as psychological prices (with 9, 95 or 98 as the last digit(s)), fractional prices (easy to pay) and round prices (multiples of 100) account for a significant share of prices currently applied in Belgian shops. Calculated on the basis of more than 105,000 prices recorded in the data set underlying the Belgian CPI of December 2000, up to 72.7% of recorded prices can be regarded as attractive in Belgium.

The first part of this paper considered the worst-case scenario whereby all attractive BEF prices, after conversion into euro, are systematically rounded up to the nearest attractive euro price. On the basis of different simulation hypotheses, the maximum effect of rounding up on the CPI would range from 0.54% to 0.72%. The impact was computed to reflect the effect of such rounding on the national CPI. But the result for the Belgian HICP should be of the same order of magnitude. The greatest impact (1.25%) is recorded in the *Food and non-alcoholic beverages* category, which is also the largest category in terms of CPI weights. However, given the degree of competition and the intentions of big retail companies in this sector, it seems unlikely that the effect of rounding will be that great.

Apart from the fact that a fairly high degree of competition on Belgian product markets will restrain the effect of rounding, it should be emphasised that the changeover is taking place in a period of economic slowdown. Hence, the prevailing demand conditions are not in favour of rounding prices systematically up. Moreover it appears that consumers are particularly vigilant and that consumer organisations, as well as the Economic Inspection of the Ministry of Economic Affairs, are monitoring the changeover process closely. Together with the commitments made by organisations representing the enterprise sector, these factors reinforce the view that results presented here should be regarded as upper limits of the impact of rounding on inflation.

The second part of the paper addressed the question of empirical evidence of rounding effects due to the April 1992 VAT rate change. Calculated on the basis of a constant sample of 28,105 prices of products undergoing a VAT rate change in April 1992, the total deviation between observed prices and new hypothetical prices amounts to - 0,2%. Seen from this perspective, it does not seem that the VAT rate change was used to increase prices unduly – on the contrary. However it should be taken into account that a large set of prices (undergoing a VAT rate modification), particularly the prices which

were subject only to small VAT rate changes, did not change between March and April 1992. What does this mean for our assessment? First, this type of short-run prices stickiness is not unusual and seems to be consistent with menu cost models. This suggests that normal economic considerations continued to prevail, thus confirming the idea that the VAT rate changes were not used to increase prices unduly. Second, not changing prices is definitely not a valid option for the cash changeover. We therefore also analysed a subsample of prices that did actually change.

Excluding the set of prices that did not change (60% of the sample), the deviation amounts to 0.8%. As, with positive inflation, the effect of regular adaptations of prices should in principle be positive, this positive deviation is not necessarily symptomatic of significant upward rounding effects. Although the impact of regular price changes between March and April is very difficult to evaluate, we have provided evidence that it could be within the range of 0.4% - 0.6%. This is very close to the global deviation mentioned above, so that rounding effects on inflation appear marginal.

The role of attractive prices was not easy to identify. When only prices that actually changed between March and April are considered, fractional prices (ending with 0 or 5) are found to have contributed significantly to the deviation, whereas psychological prices (ending with 9, 95 or 98) had, if anything, a downward impact.

From the evolution of the proportion of attractive prices over a longer period it can be observed that it took between 11 and 17 months to compensate for the 6% decline in the proportion of attractive prices following the VAT change in April 1992. However, it is not realistic to extrapolate these results to the euro changeover. The adjustment period has probably already started.

All in all, it should be emphasised that the major difficulty encountered was that of isolating rounding effects from regular price changes. Any ex post assessment of the cash changeover will face the same difficulty. This indicates that the evolution of the prices currently observed should be interpreted with caution. Even if evidence were found that converting attractive BEF prices into attractive euro prices coincided with price increases, it should be taken into account that the latter may be due to cost increases totally unrelated to the changeover, such as for instance higher prices for intermediary inputs or higher wages. Taking these factors into account it is unlikely that the inflation figures currently observed underwent a significant upward euro-rounding effect.

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